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TWO NEW SPECIES OF OCTOPODS OF THE GENUS
GRANELEDONE (MOLLUSCA: CEPHALOPODA)
FROM THE SOUTHERN OCEAN¹

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The cephalopod collections taken from Antarctic seas by the USNS *ELTANIN* are rich in benthic octopods. These are being worked upon by the writer and the final results will form a monographic study of the octopods of the Southern Ocean. Because of the time involved in working up the collections and the complexities of the taxonomic problems, the descriptions of the new species are being published separately in a series of papers in order to make them immediately available to other students of the group.

The genus *Graneledone* is poorly known. Most of the species descriptions are inadequate for identification and comparisons, and, due to the poor state of preservation of most of the material, little is known concerning the internal anatomy of the component species. The present paper helps to remedy this situation and is preliminary to a more detailed and comprehensive study of the genus.

I wish to thank those responsible for the collection and preservation of the specimens, for their care in handling them, and for their excellent state of preservation. I also wish to thank Dr. George Llano, head of the Biology Program of the NSF Office of Antarctic Programs, for making this work possible. This research was supported by National Science Foun-

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The illustrations of *Graneledone macrotyla* are by Constance Stolen McSweeney; the drawings of *G. antarctica* are by the writer; Roger Hanlon took the photographs. The measurements and indices used are those defined by Voss (1963:11). The types are deposited in the U.S. National Museum of Natural History.

***Graneledone antarctica*, new species**

Figures 1a-i, 2

Material studied: Holotype—male, mantle length 41 mm, from Ross Sea, Eltanin Sta. 2110, 74°05.6'S, 175°05.2'W in 2341 m with 10-foot Blake trawl, February 8, 1968, USNM 729679. Paratypes—male, mantle length 39 mm, female, mantle length 45 mm, UMML 1667. Male, mantle length 38 mm, 3 females, mantle length 25–41 mm, USNM 729680. (All paratypes with same data as holotype.)

Description: The mantle is short, broadly rounded posteriorly, and very wide. It is distinctly flattened dorso-ventrally. The head is set off from the mantle by a slight constriction. The head is nearly as wide as the mantle, flattened, and bears large conspicuous eyes.

The funnel is of moderate size; it is free for its anterior half which is tubular and tapered. The funnel organ is VV-shaped but shows considerable variation (Figs. 1a, b). It is composed of 2 elongate oval pads slightly to moderately split anteriorly with pointed to blunt tips.

The arms are long and rather stout; the arm order is 1.2.3.4, either I or II always being the longest and IV always the shortest. The web is moderately deep with the formula $C = B.D.A = E$ but showing some individual variation. The web extends only a short distance up the dorsal side of each arm after which there is no trace. On the ventral side of I, II, and III the web extends to the tip of the arm. It is low in the basal half but at about the midpoint of the arm it broadens, becoming widest at about the distal $\frac{1}{5}$ of the arm. Only the extreme tip of the arm is free. On preservation, the contraction of the web curls the arm tip in a pronounced fashion. The arm web attains its greatest development on I and II. The suckers are small and in a single row on each arm. They are largest near the base of the arm and regularly decrease in size toward the arm tip.

The third right arm is hectocotylyzed in the male. It is bordered ventrally by a membrane or web, its outer margin thickened, cream-colored, and rolled outward. The contraction of this thickened border curls the arm tip downward resembling a hook or a slight S-curve. This shape is probably not found in the living animal but is due to the action of the preservative. The tip of the arm bears a small ligula (Fig. 1c). It is spoon-shaped, pointed distally, and has thickened margins. The

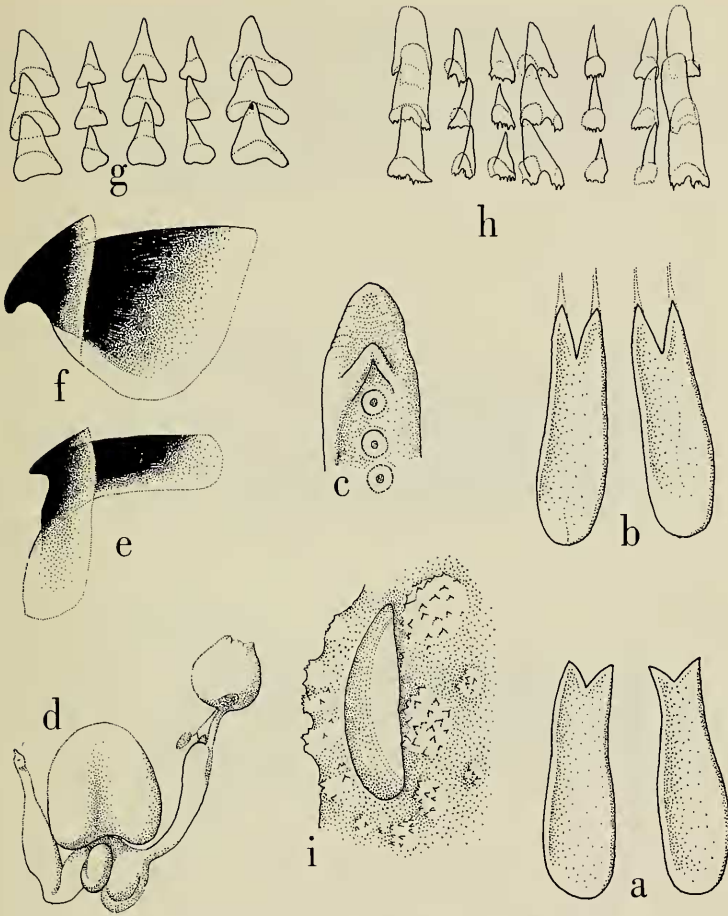


FIG. 1. *Graneledone antarctica*, new species. a-b, Funnel organs; c, Hectocotylus of holotype; d, Digestive tract of female; e-f, Mandibles; g, Radula of 39 mm specimen; h, Radula of 38 mm specimen.

oral face is crossed by about 12-13 low fleshy folds. The calamus is projecting, low, and blunt.

The gills are short, stout, and contain 6 lamellae on the outer demi-branch.

None of the specimens appear to be sexually mature. The holotype had a well developed hectocotylus and penial apparatus but there were no spermatophores in Needham's sac nor were any found in the other males.

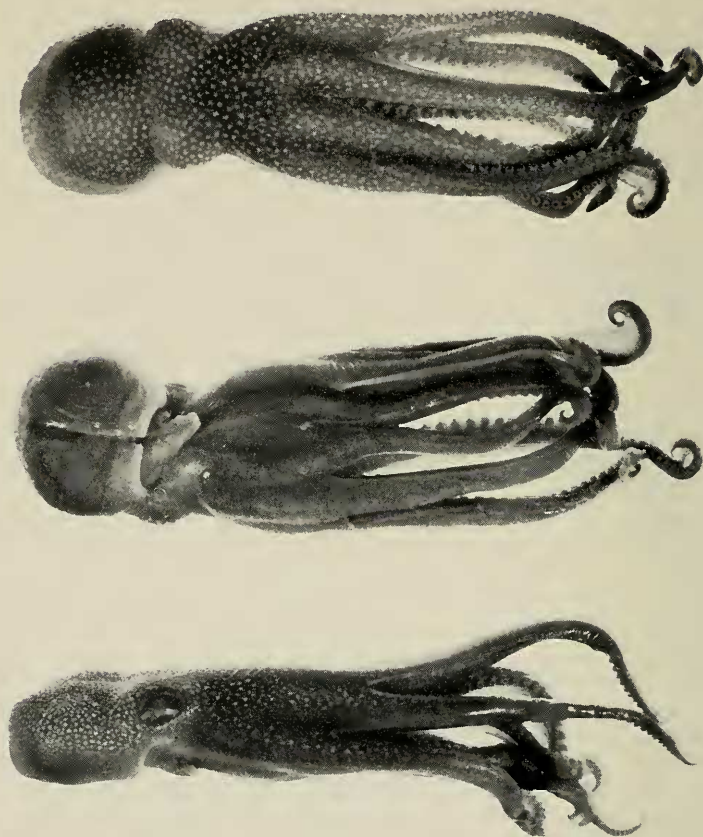


FIG. 2. *Graneledone antarctica*, new species. Upper figures of holotype; lower figure of 38 mm paratype.

None of the females contained developed eggs.

The digestive tract was dissected from one of the large females (Fig. 1d). The buccal mass is large and contains large anterior salivary glands. The paired posterior salivary glands are very small and poorly developed. The esophagus leads from the buccal mass posteriorly to the crop which it enters dorsally. The latter has no diverticulum. Posteriorly the esophagus and crop lead into a stout portion which connects with a moderately large two-parted stomach, one part thick-walled and muscular, the other thin-walled. The spiral caecum is small, stout, smooth externally, and united with the small heart-shaped liver by paired hepatopancreatic ducts. The intestine is stout, thin-walled, and leads anteriorly to the anus which does not appear to have anal flaps. The crop was opened

in one specimen. It contained an amorphous mass of animal tissue in which numerous polychaete bristles were embedded.

The beaks show no unusual features (Figs. 1e, f).

Radulas were removed from two specimens. While there is no question that all of the specimens are conspecific and show a remarkably close conformity in other characters, the radular teeth vary greatly. The radula from specimen No. 2 (Fig. 1g) has only 5 teeth in each transverse row, none of them showing any great dissimilarity. The rachidians are undifferentiated but somewhat larger than the second laterals and without cusps. The admedians or first laterals are missing. The second laterals are only slightly curved with small bases; the third laterals are largest, tallest, and broadest, with conspicuous bases. There is no trace of marginal plates.

The radula of specimen No. 3 (Fig. 1h) has rather large, broad rachidians with broad bases, perhaps somewhat distorted in the figure by a sidewise orientation in the mount. The admedians are a little shorter than the second laterals, narrow and sharp. The second laterals are larger and more curved. The third laterals are very broad, almost flattened at their tips and show a slightly irregular outline. All of these teeth stand erect, are thin and transparent, and in No. 3 have very irregular almost root-like bases.

All of the specimens were fixed in 10 percent buffered formalin after brief emersion in fresh water to kill them. They were thus fixed without undue distortion of the arms and were later transferred to 70 percent alcohol. They are in remarkably fine condition for examination.

The general consistency is muscular with a thick overlying layer of almost gelatinous material, particularly posteriorly on the mantle and slightly less so dorsally, around the head and eyes, and surrounding the brachial crown. The surface is covered by a thin, very tough skin which is covered dorsally on the mantle, head and arms by numerous, evenly spaced, close-set warts (Fig. 2). These consist of a raised mound bearing from one to over a dozen small, cone-shaped papillae. They are very regularly distributed. There are none on arms IV; arms II and III are liberally covered dorsally but there are none ventrally. There is a distinct line of fine warts on the periphery of the mantle arranged like a keel running from the corners of the mantle aperture around the mantle posteriorly. Below the keel there are no warts and the surface is smooth. There are no warts beneath the head except for a few bordering the lower eyelid and immediately adjacent to it. There is a distinct circling of warts on the eyelid (Fig. 1i). These are somewhat larger than the other warts and two or three of them over each eye are greatly enlarged and, although not erected, probably represent ocular cirri.

The color of specimens in alcohol is a pale yellowish brown dorsally, suffused with purplish hues at the base of the brachial crown and on and between the arm bases. On this ground color the mantle, head, funnel, and the base of the arms are reddish brown suffused with purple. The spermatophoral groove on the third right arm is yellowish.

TABLE 1. Measurements (in mm) of 3 male specimens of *Graneledone antarctica*, new species, from ELTANIN Sta. 2110.

No.	Holotype					
	1		2		3	
Mantle length	41		39		38	
Mantle width	44		37		40	
Head width	40		34		38	
Arm length I	164	165	138	138	138	136
II	164	164	123	130	127	136
III	150	145	112	105	119	117
IV	135	135	103	98	113	105
Total length	208		179		178	
Arm width	8.0		7.0		7.0	
Hect. arm length	145		105		117	
Ligula length	4.5		4.0		3.8	
Calamus length	2.0		2.0		1.5	
Sucker diameter	3.3		2.3		2.2	
Web depth A	28		30		25	
B	46	47	35	38	33	42
C	45	52	35	35	38	38
D	33		27		30	
Gills	6		6		6	

TABLE 2. Indices of bodily proportions of three males of *Graneledone antarctica*, new species, from ELTANIN Sta. 2110.

No.	1	2	3	N	Range	S.D.
ML	41	39	38	3	38.0 - 39.3 - 41	1.52
MWI	107.3	94.9	105.3		94.9 - 102.5 - 107.3	6.65
HWI	97.6	87.2	100.0		87.2 - 94.9 - 100.0	6.80
MAI	24.9	28.3	27.5		24.9 - 26.9 - 28.3	1.77
ALI	79.3	77.0	77.5		77.0 - 77.9 - 79.3	1.20
AWI	19.5	18.0	18.4		18.0 - 18.6 - 19.5	0.77
WDI	31.5	27.5	30.4		27.5 - 29.8 - 31.5	2.06
SIn	8.0	5.9	5.8		5.8 - 6.6 - 8.0	1.24
HcAI	87.8	76.1	84.8		76.1 - 82.9 - 87.8	6.07
LLI	3.1	2.8	3.2		2.8 - 3.0 - 3.2	0.20
CLI	44.4	50.0	39.5		39.5 - 44.6 - 50.0	5.25
PLI						
Arm formula	1.2.3.4	1.2.3.4	1.2.3.4			
Web formula	CBDEA	BCDAE	CBDEA			
Gills	6	6	6			

TABLE 3. Measurements (in mm) of four females of *Graneledone antarctica*, new species, from ELTANIN Sta. 2110.

No.	4		5		6		7	
Mantle length	45.0		41		39		25	
Mantle width	43		37		36		23	
Head width	40		32		34		23	
Arm length I	131	134	99	102	116	115	60	62
II	134	134	98	99	108	114	62	61
III	122	118	97	93	96	102	58	60
IV	198+	114	86	57+	96	101	59	56
Total length	177		143		157		88	
Arm width	8.0		5.5		6.0		6.0	
Web depth A	32		25		28		17	
B	41	42	30	32	32	37	18	—
C	42	43	35	33	32	37	21	20
D	37	38	32	32	32	31	19	17
E	31		20		22		17	
Gills	6		6		6		6	

+ = tip broken

Holotype: U.S. National Museum of Natural History 729679.*Type-locality*: Ross Sea, Antarctica, ELTANIN Sta. 2110, 74°05.6'S, 175°05.2'W in 2341 m.*Discussion*: Two other species assigned to *Graneledone* must be considered: *G. challengerii* (Berry, 1916) and ? *G. setebos* Robson, 1932.*G. antarctica* superficially resembles *G. challengerii* in its bodily proportions. It differs from it in the structure of the funnel organ, hectocotylus, radula, and sculpture. The funnel organ in *antarctica* is formed of double oval pads slightly to moderately spilt anteriorly; in *challengerii* these organs are typically VV-shaped with narrow, pointed, anteriorTABLE 4. Indices of bodily proportions and counts of four females of *Graneledone antarctica*, new species from ELTANIN Sta. 2110.

No.	4	5	6	8	Range	S.D.
ML	45	41	39	25	25 - 37.5 - 45	8.69
MWI	95.6	90.2	92.3	92.0	90.2 - 92.5 - 95.6	2.25
HWI	88.9	78.1	87.1	92.0	78.1 - 80.5 - 92.0	5.97
MAI	33.6	40.2	33.6	40.3	33.6 - 36.9 - 40.3	3.83
ALI	75.7	71.3	73.9	70.5	70.5 - 72.8 - 75.7	2.39
AWI	17.8	13.4	15.3	24.0	13.4 - 17.6 - 24.0	4.61
WDI	32.1	34.3	31.9	33.9	31.9 - 33.1 - 34.3	1.22

limbs. In *antarctica* the ligula is small and moderately well differentiated; in *challengeri* the ligula is well formed, deeply excavated, with sharply differentiated calamus. The radula of *antarctica* is highly variable but shows a general uniformity of teeth; in *challengeri* the radula is more typically octopodan. The sculpture of *antarctica* varies from *challengeri* in the more scattered, more widely separated tubercles, and the presence of 2 to 3 much larger tubercles over the eyes. The wide membrane on the ventral side of the arms in *antarctica* also seems distinctive.

There is no point of comparison with ? *G. setebos* for the reasons given in the general discussion.

The etymology of the name is self-evident.

***Graneledone macrotyla*, new species**

Figures 3a-g

Material studied: Holotype, a female, mantle length 34.5 mm, EL-TANIN Sta. 1592, 54°43'S, 55°30'W in 1647-2044 m with 10-foot Blake trawl, March 14, 1966. USNM 729678.

Description: Only a single specimen of this species was found in the collections. It is, however, so different from any known species of *Graneledone* that I do not hesitate to describe it as new.

The mantle wall is thick and muscular with some semigelatinous material forming an outer layer. The mantle is large, round, but somewhat dorsoventrally flattened, and is very wide. There is no noticeable constriction between the mantle and the head (Fig. 3a, b).

The mantle aperture is small and the funnel-mantle locking apparatus is weakly developed. The funnel is stout and tubular but it is united to the ventral surface of the head for most of its length. The funnel is VV-shaped and stout with broad lateral limbs slightly stouter than the median limbs (Fig. 3c).

The head is broad with medium sized eyes which do not project. There is a slight constriction between the head and the bases of the arms.

The brachial crown is well developed. The arms are moderately long, stout, and taper gradually to slender points. The arm formula is 2.3.1.4. The suckers are small and crowded together but arranged regularly in a single row.

The web is moderately deep. The web formula is C.D.B = A.E. The web extends as a broad membrane up the ventral side of each arm nearly to the tip.

The mantle had been opened in search of mesozoan parasites and some of the internal organs were damaged. The gills are small, about equally developed in each demibranch, with 7 lamellae, including the terminal ones, on the outer demibranch.

The digestive tract was dissected (Fig. 3d). The beaks offer no particular differences but are well developed (Fig. 3e). The radula consists of a rachidian with asymmetrically arranged cusps as shown in the

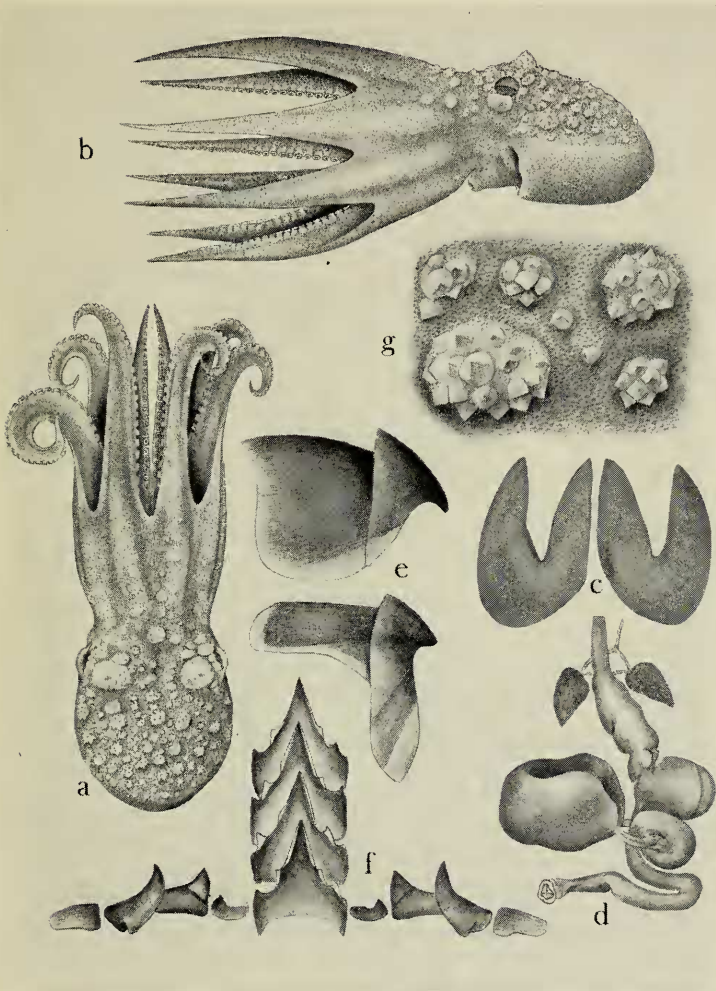


FIG. 3. *Graneledone macrotyla*, new species. Holotype: a-b, Dorsal and ventral views; c, Funnel organ; d, Digestive tract; e, Mandibles; f, Radula; g, Details of tuberculations.

figure (Fig. 3f). The admedian is small and somewhat bicuspid with the outer cusp more pronounced. The second lateral has a broad inner cusp with a short base. The third lateral is short, stout, and broad. The marginal plates are roughly triangular and rugose, the ridges or plications extending longitudinally of the plate.

TABLE 5. Measurements (in mm) and indices of the female holotype of *Graneledone microtyla*, new species.

Mantle length	34.5		
Mantle width	38.0	MWI	110.0
Head width	36.0	HWI	104.0
Arm length I	81.0	ALI	70.0
II	87.0	MAI	39.7
III	83.0		
IV	80.0		
Sucker diameter	2.5	S1 _n	7.2
Arm width	7.5	AWI	21.7
Length of gills	8.0		
Gills	7		
Total length	124.0		
Web depth A	24.0	WDI	32.2
B	24.0		
C	28.0		
D	25.5		
E	20.0		
Arm formula	2.3.1.4		
Web formula	CDB = AE		

The anterior salivary glands are small; the posterior salivary glands are triangular and small. The esophagus is stout and along much of its length is slightly dilated forming an indistinct crop of the type shown by Robson (1932, Fig. 30b) for *Bathypolypus* and which in fact is not a crop. This dilated portion of the esophagus leads into a strongly differentiated two-parted stomach and a distinct large, spiral caecum. The intestine is large, slightly dilated, and bent almost double upon itself. The anal pore is round, without the usual anterior and posterior folds or lateral flaps. There is no trace of an ink sac.

The crop and stomach were opened but contained little food remains. None was identifiable.

The genitalia unfortunately were removed at the time of capture while searching for mesozoans.

The sculpture is distinctive (Fig. 3a, b, g). There is a low, thin, peripheral keel or raised line around the mantle. Above the keel the surface is covered with well separated, distinct rugosities consisting of simple, sharp, cartilaginous tubercles, slightly larger groups of simple tubercles, and large areas 3-7 mm in diameter consisting of a pale raised area with small, simple tubercles surrounding an erect, central, sharp spine. There is a row of tuberculous papillae around each eye and a gigantic tuberculate cirrus about 10 mm in diameter above each eye. A color photograph of the living animal taken aboard the ship shows the two cirri erected to a height of about 15 mm. The tuberculations extend

onto the web and bases of the arms nearly to the level of the web margin. There are no tubercles on arms III and IV nor on the ventral surface of the head and mantle.

The color is a brownish red with deeper purple in the area of the brachial crown. The raised pale areas are creamy brown.

Holotype: U.S. National Museum of Natural History 729678.

Type-locality: Near the Falkland Islands, Eltanin Sta. 1592, 54°43'S, 55°30'W in 1647–2044 m.

Discussion: *G. macrotyla* resembles no other member of the genus in its superficial appearance. The few tubercles varying in size from minute to extraordinarily large ones, with a single enormous tubercle over each eye, immediately separates this species from all others in the genus. The radula is even more octopodan in general shape than that of *G. challenger* which it most closely resembles in this feature.

The name *macrotyla* is derived from the Greek meaning large knobs and refers to the large tuberculations characteristic of the species.

GENERAL DISCUSSION

The genus *Graneledone* Joubin, 1918 may be diagnosed as follows: suckers uniserial; ink sac absent; funnel organ VV-shaped; crop reduced or absent; gills small; hectocotylus small; mantle and arms covered with small to large cartilaginous spiny warts. Robson (1932), listed four taxa: *G. verrucosa* (Verrill, 1881), *G. verrucosa media* (Joubin, 1918), *G. challenger* (Berry, 1916), and ? *G. setebos* Robson, 1932.

G. verrucosa, and its possible subspecies *media*, is a North Atlantic species about which surprisingly little is known. From the literature, however, it differs considerably from the new species under consideration. At present, I am inclined to believe that the two forms do not warrant separation and represent a northern hemisphere species.

G. challenger, of which the type is from off the Kermadec Islands, is confused because Robson (1932:311) included in his description Hoyle's (1904:21) *Moschites verrucosa* from the Gulf of Panamá. This latter specimen needs reexamination, including study of other now available specimens from the same region.

? *G. setebos* was first described by Massy as *Moschites* sp. (Massy, 1916:159). Robson (1932:313) placed the species in *Graneledone* without giving a single character to support his decision. None of the characters given either by Massy or Robson indicates that the specimen was a *Graneledone*. The specimen was taken dead in a rock pool and was badly decomposed so that no observations were possible concerning skin and sculpture, color, funnel, funnel organ, ink sac, etc. In my opinion *G. setebos* is a *species dubia* and should be dropped from further consideration.

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